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09/806542

SPECIFICATION

JC08 Rec'd PCT/PTO 30 MAR 2001

TITLE

METHOD FOR DETERMINING THE POSITION OF TEXT LINES IN TEXT RECOGNITION TASKS

BACKGROUND OF THE INVENTION

Background of the Invention

[0001] The invention relates to a method for determining the position of text lines in text recognition tasks in which the brightness distribution of an acquired image excerpt along the vertical is determined by histogram formation along the lines, and this brightness distribution is smoothed. A maximum value and minimum value of the function obtained in this way are determined, and thresholds that serve as the basis for distinguishing between text line and text interspace are calculated on the basis of these extremes.

Field of the Invention

[0002] In the case of the automatic recognition of texts, that is to say in the case of the conversion of the graphical information of a document into text characters which can be further processed by means of electronic text processing programs, an essential prerequisite for a successful recognition operation is that the position and the size of the individual characters be determined accurately. This presupposes in turn that the position and the dimensions of the text lines be known.

[0003] In the case of manually guided readers, moreover, the profile of the text lines in the captured image excerpt turns out to be non-linear. In this context, there is a need to determine the profile of a text line.

[0004] A method of the species initially cited is disclosed by EP 0702 329 A2. This publication discloses a method and an apparatus for determining the line course given handwritten documents. According to this publication, the picture elements are summed up line-by-line, smoothed and analysed for the determination of the position of the lines.

SUMMARY OF THE INVENTION

[0005] The invention is based on the object of improving this method.

[0006] This is done according to the invention by a method of the type mentioned in the introduction in which a line interspace is identified when the function comprises a combination of a maximum with a minimum. The minimum comprises a value less than *function minimum + plurality of picture elements over the width of the image excerpt/15 + 2*plurality of the picture elements over the width of the image excerpt / 15 * function maximum / plurality of picture elements over the width of the image excerpt* and the drop off of the function values after the maximum comprises a value greater than *(function maximum - function minimum)/2*. This embodiment has proven itself in practice on the basis of very good results.

[0007] An advantageous refinement of the method is provided in which, in order to ascertain the left-hand edge of a line, the brightness distribution of a captured image excerpt along the horizontal is determined and the function obtained in this way represents the beginning of a line by an abrupt rise in the function value. The beginning of a line can thus be determined in a simple manner with little complexity. Furthermore, for the determination of the position of the text lines, it can be ensured that in this case only images which actually contain text lines are taken into consideration and a user error, such as e.g., positioning the reading pen too far to the left of the beginning of a line, does not influence the determination of the line.

[0008] It is expedient if, after the position of a line has initially been ascertained, the further course of the line is determined by evaluating the information concerning the text characters recognized. Evaluating the results of the character classification enables the line profile to be determined particularly accurately.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention is explained in more detail with reference to the following exemplary figures.

[0010] Figure 1 is a diagram of a screen shot showing a text excerpt of the kind that is typically captured by a manually guided reader, and also the histogram determined from it; and

[0011] Figure 2 shows the filtered histogram with the parameters entered for the assessment of the image.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The sequence of the method according to the invention is as follows:

[0013] A line histogram is determined for the captured image excerpt. In this case, for each line, the values of all the pixels of this line (0 for white and 1 for black) are summed. The result is a function f(y) with

[0014] $$f(y) = \sum_{i=0}^{Width-1} (BlackPixel)$$ where:

[0015] y denotes the line index of the image; and

[0016] Width indicates the width (number of columns) of the image excerpt.

[0017] When a text is present, this function has a typical profile as illustrated by way of example in Figure 1. In a further step, filtering is carried out in accordance with

[0018] $$f'(y) = \frac{\sum_{i=-5}^{+5} (f(y+i) * G(i))}{\sum_{i=-5}^{+5} G(i)}$$

[0019] where:

[0020] y index in the line histogram;

[0021] G weighting corresponding to an exponential smoothing curve; and

[0022] i index of the smoothing curve.

[0023] During the filtering operation, values are also determined for the absolute maximum *Valuemax* i.e., the number of black pixels of the darkest line and the absolute minimum *Valuemin* i.e., the number of black pixels in the brightest line.

[0024] Parameters for the assessment of the image are derived from these two values. These parameters are:

[0025] *Trough limit = (Valuemax - Valuemin)/2*

[0026] but at least *number of pixels over the width of the image excerpt/30*

[0027] *Minima edge = Valuemin + number of pixels over the width of the image excerpt/15*.

[0028] but at most 2**number of pixels over the width of the image excerpt/15*

[0029] *Minima threshold = minimum edge + (2*number of pixels over the width of the image excerpt/15 * (Valuemax/number of pixels over the width of the image excerpt))* .

[0030] but at most 3**number of pixels over the width of the image excerpt/15.*

[0031] Using the function f'(y) and the threshold values determined, as are illustrated by way of example in Figure 2, the captured image is then assessed with regard to the presence of text lines and line interspaces.

[0032] For this purpose, the curve profile is examined to see whether values which are smaller than the parameter *minima threshold* are present. If this is the case, then the relevant area is qualified as a valid minimum and thus as a possible line interspace.

[0033] An actual line interspace is present, however, only when the presence of a text line is indicated by an adjoining maximum with a certain characteristic value. These valid maxima are defined by a subsequent decreasing of the curve value by a magnitude > *Trough limit*.

[0034] The coincidence of a valid maximum with a valid minimum characterizes the transition from a text line to a line interspace. The parameter *Minima edge* serves for accurately determining this transition.

[0035] The point at which the curve intersects this threshold between a valid maximum and a valid minimum is defined as a line edge.

[0036] In order to determine the left-hand edge of a line, a column histogram is created in accordance with

[0037] $$f(x) = \sum_{i=0}^{Height-1} (BlackPixel)$$

[0038] wh[redacted]

[0039] x column index of the image excerpt; and

[0040] Height image height

[0041] in words the colour information of the pixels of each column of the captured image excerpt is summed. The left-hand text edge is defined (given the presence of at least one line) by an abrupt rise in the function value f(x).

[0042] The follow-up plotting of the lines (i.e., the information concerning the further profile of the lines, which is important particularly in the case of manually guided readers on account of the fluctuations that occur with the latter) is effected on the basis of the position of the recognized characters.

[0043] For this purpose, the recognized characters are classified into the following size groups:

[0044] Small characters (for example "a") 0.7*line height;

[0045] Large characters (for example "A","g") line height;

[0046] Oversize characters (for example "[","j") line height +0.3*line height (descenders);

[0047] Special characters: the characters cannot be unambiguously assigned by size.

[0048] The following character groups are differentiated for the determination of the new lower edge of the text line:

[0049] Baseline characters (for example "A", "."): the lower edge of the character corresponds to the lower edge of the text line, irrespective of the size of the character;

[0050] Descender characters (for example "g", "["): the lower edge of the character corresponds to the descender boundary, irrespective of the size of the character;

[0051] Special characters: these characters cannot be unambiguously assigned with regard to their lower edge.

[0052] On the basis of these assignments and a probability value G relating to the correct classification of the character, this probability value being obtained in the course of the classification method, the new line height *Height* is then determined as follows:

[0053] $$G = Probability * \mathrm{CYC\_MAX\_WEIGHT}$$

[0054] $$Height = \frac{\sum_{i=0}^{\mathrm{CYC\_MAX\_EXTRPAR}-1} OldHeight[i] + NewHeight * G}{\mathrm{CYC\_MAX\_EXTRPAR} + G}$$

[0055] G weighing of the line height derived from the current character;

[0056] Probability probability of correct character classification (range of values between 0 and 1);

[0057] CYC_MAX_WEIGHT maximum weighing of the new character position (for example: 5);

[0058] Height subsequently plotted line height (upper case letter height);

[0059] CYC_MAX_EXTRPAR size of the ring buffer for the averaging (for example: 3);

[0060] OldHeight[] ring buffer;

[0061] NewHeight line height derived from the current character (upper case letter height); and

[0062] i index in the ring buffer.

[0063] The profile of the lower edge of the text line is determined in accordance with:

[0064] $$G = \left(Probability + \frac{1}{\mathrm{CYC\_MAX\_WEIGHT}} \right) * \mathrm{CYC\_MAX\_WEIGHT}$$

[0065] $$Increase = \frac{OldIncrease + NewIncrease * G}{1 + G}$$

[0066] $$Base = NewBase + \frac{Increase * DeltaX + 50}{100}$$

[0067] G weighing of the new character position;

[0068] P[redacted]ability probability of correct character classification;

[0069] CYC_MAX_WEIGHT maximum weighting of the new character position (for example: 5);

[0070] Increase subsequently plotted current gradient of the baseline in %;

[0071] OldIncrease previous gradient of the baseline in %;

[0072] NewIncrease gradient of the base line in % calculated from the position of the current character;

[0073] Base subsequently plotted baseline position (rounded to an integer value);

[0074] NewBase baseline position calculated from the position of the current character; and

[0075] DeltaX X-separation in the image between the two centre points of the characters extracted last.

[0076] The "Increase" is limited by the plausibility limit CYC_MAX_LINEOFFSET (in the Pocket Reader: 15%).

[0077] The above-described method is illustrative of the principles of the present invention. Numerous modifications and adaptations will be readily apparent to those skilled in this art without departing from the spirit and scope of the present invention.